

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: S. Blackwell

Serial No.:

Filed: February 28, 2001

For: IMPROVED METHOD AND APPARATUS FOR ECHO CANCELLATION



Examiner:

Group Art Unit: 2733

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PRELIMINARY AMENDMENT

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February 28, 2001

Date of Deposit

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PTO Reg. No.

February 28, 2001

Date of Signature

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Amendment

In the specification at page 1, after "Background Of Invention" insert the following new paragraph:

This application is a divisional application of U.S. application no. 08/941,911, filed on October 1, 1997, and entitled IMPROVED METHOD AND APPARATUS FOR ECHO CANCELLATION.

Please cancel claims 2-5 and 7-10 without prejudice.

Please amend claims 1 and 6 as follows:

1. (Amended) A method for echo cancellation in a communication system utilizing a bidirectional transmission medium, said method comprising the steps of:

(a) generating a first signal at a first sampling [signaling] rate within a first frequency band, said first signal characterized by an echo at said first sampling [signaling] rate within said first frequency band;

(b) transmitting said first signal in a first direction through said bidirectional medium;

(c) receiving a second signal in a second direction through said bidirectional medium at a second sampling [signaling] rate within a second frequency band, said first and second frequency bands being partially overlapped, said second sampling rate being less than said first sampling rate; and, [;]

(d) canceling said echo from said second signal, said canceling step including the step of replicating [an] said echo by sampling said first signal at said second sampling rate [within said second frequency band], whereby said echo canceling is performed within said second frequency band.

6. An apparatus for echo cancellation in a communication system utilizing a bidirectional transmission medium, said apparatus comprising:

(a) an information source for generating a first signal at a first [signaling] sampling rate within a first frequency band, said first signal characterized by an echo at said first [signaling] sampling rate within said first frequency band;

(b) a transmitter for transmitting said first signal in a first direction through said bidirectional medium;

(c) a receiver for receiving a second signal in a second direction through said medium at a second [signaling] sampling rate within a second frequency band, said first and second frequency bands being partially overlapped, said second sampling rate being less than said first sampling rate; and, [;]

(d) an echo canceler for canceling said echo from said second signal, said canceler comprising an echo replica unit for replicating [an] said echo by sampling said first signal at said second sampling rate [within said second frequency band], the combination being so constructed and arranged that said canceling is performed within said second frequency band.

Remarks

Applicants have amended claims 1 and 6, without prejudice and without acknowledgement that the Ribner '809 reference is effective prior art under 35 U.S.C. § 102(e), to incorporate the patentable difference between their inventions as defined in those two claims and the Ribner '809 patent.

The Ribner '809 patent describes a conventional DMT FMT system wherein the transmit ("TX") is the bandwidth of channels 35-511 and the receive ("RX") bandwidth is the bandwidth of channels 1-31. Therefore, there is no overlap between the TX and the RX bands, whereas applicants disclose and claim methods and apparatus in which signals A and B are transmitted in frequency bands BW_A and BW_B , respectively, wherein bandwidth BW_B partially overlaps bandwidth BW_A . (Spec. at page 11/17 to 12/14). Moreover, as is described with reference to FIG. 3 of the Ribner '809 patent, echo is the result of a complex interaction of signals in channels 1-31 at the remote end via the hybrid. See Ribner '809 at col. 4/68-5/5.

Furthermore, with reference to the description of FIGS. 4A, 4B of the Ribner '809 patent, the up-stream signal transmitter (FIG. 4B) samples at a Nyquist rate of $1/8^{\text{th}}$ of the frequency " f_s "

whereas echo canceling in FIG. 4A (the down-stream signal transmitter) is done at a sampling rate $N f_s / 8$ (where N is equal to or less than 8) times that Nyquist rate. Moreover, the down-stream signal transmitter (FIG. 4A) samples at a different Nyquist rate (f') and echo canceling in the up-stream transmitter (FIG. 4B) is done at that same rate. See Ribner '809 patent at col. 9/23-29.

In the present invention, with reference to FIG. 2, the downstream signal is the wideband BW_A signal and the upstream signal is a narrower, partially overlapping bandwidth BW_B . Unlike the Ribner '809 patent, in the present invention, the pass band of the upstream signal partially overlaps the pass band of the downstream signal. In Ribner '809, the upstream signal is transmitted in a bandwidth that is lower than the bandwidth of the downstream signal, so that there is no overlap of the two bandwidths. See Ribner '809 at col. 5/26-32, 6/47-51, 7/18-21. FIG. 3 of Ribner '809, which is discussed at col. 5/63-64, 9/47 ff. and 9/65 ff., merely illustrates "curves useful in understanding problems" allegedly faced by the inventors, without any significant discussion of the curves – FIG. 3 merely shows that echo gets "smeared" going through the cable and not transmission of information signals in overlapping bandwidths as is disclosed in the present application.

Moreover, also unlike the Ribner '809 patent, in the present invention, echo canceling of the downstream signal, e.g., at the central office transceiver, occurs at the Nyquist rate of the upstream signal transmitter, i.e., at a rate less than the Nyquist rate of the transmitter (see specification at page 16/9-10) and not at N -times that rate, as is disclosed in the Ribner '809 patent.

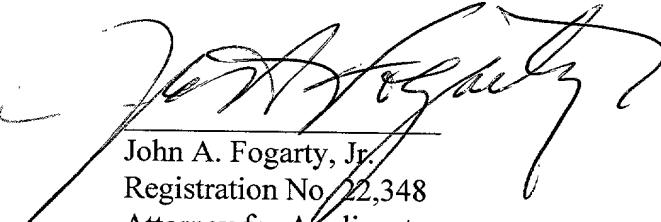
The applicants have amended independent claims 1 and 6 to expressly recite these significant patentable differences between their invention and the Ribner '809 patent, namely, that applicants' echo cancellation in the central office transceiver takes place at a sampling rate that is less than the Nyquist rate of the transmitter being echo canceled, e.g., at the sampling rate of the upstream transceiver. These claim amendments are supported in the specification, *inter alia*, at page 16/4-13, page 17/6-9, page 18/12-20, and page 19/1-8.

It is known by those of skill in the art of signal processing that an analog signal must be sampled at the Nyquist rate in order to completely reconstruct the signal. Applicants have discovered that sampling at less than the Nyquist rate for the echo canceling method and apparatus described in the specification can reduce complexity and provide performance equivalent to prior art echo canceling methods. Echo canceling in accordance with applicants' methods and apparatus reduces computations by eliminating computations that are not needed, a technique and result that cannot be used or even achieved in the Ribner '809 system. Applicants' invention not only reduces the complexity of the echo canceling apparatus, but also provides performance equivalent to echo canceling as taught in the prior art, e.g., the Ribner '809 patent, where sampling takes place at a rate that is N times larger than the Nyquist rate of the transmitter being echo canceled.

Applicants cancellation of claims 2-5 and 7-10 is without prejudice to their right to secure issuance of those claims in the parent application, 08/941,911 filed on October 1, 1997, wherein

those claims were held to be allowable by Examiner.

Respectfully submitted,



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